[SPECIFICATION]

[TITLE OF THE INVENTION]

SUBSTRATE BONDING APPARATUS FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 and FIG. 2 schematically illustrate a substrate bonding apparatus for manufacturing an LCD device according to the related art.

FIG. 3A illustrates an initial state of a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

FIG. 3B illustrates respective stages in a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

FIG. 4A and FIG. 4B illustrate substrate bonding apparatus for manufacturing an LCD device for preventing respective stages from being bent according to the preferred embodiments of the present invention.

FIG. 5 illustrates the process for loading respective substrates on a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

FIG. 6 illustrates the process for affixing loaded substrates to respective stages in a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

FIG. 7A and FIG. 7B illustrate the process for making a vacuum state in a chamber unit of a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

FIG. 8 illustrates the process for venting the inside of a chamber unit in a substrate bonding apparatus for manufacturing an LCD device according to the present invention.

Description of reference numerals for main parts in the drawings

100: base frame	210: upper chamber unit
220: lower chamber unit	230: upper stage
231, 241: adsorbing plate	232, 242: affixing plate
240: lower stage	250: O-ring
910: loading unit	

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND DISCUSSION OF THE RELATED ART]

The present invention relates to a manufacturing apparatus, and more particularly, to a substrate bonding apparatus for manufacturing an LCD device, which is advantageous to a large-sized LCD device using a liquid crystal dispensing method.

In general, recent developments in the information communication field have increased demand for various types of displays devices. In response to this demand, various flat panel type displays such as liquid crystal display (LCD), plasma display panel (PDP), electro-luminescent display (ELD), and vacuum fluorescent display (VFD) have been developed to replace conventional cathode ray tube (CRT) devices.

In particular, the LCD devices have been used because of their high resolution, lightness in weight, thin profile, and low power consumption. In addition, the LCD devices have been implemented in mobile devices such as monitors for notebook

computers, and the LCD devices have been developed for monitors of computer and television to receive and display broadcasting signals.

Accordingly, efforts to improve image quality of the LCD devices contrast with the benefits of high resolution, lightness in weight, thin profile, and low power consumption. In order to incorporate the LCD devices as a general image display, image quality such as fineness, brightness, large-sized area, for example, must be realized.

A method for manufacturing the LCD device according to the related art is classified into a general liquid crystal injection method, and a liquid crystal dispensing method. The liquid crystal injection method includes steps of forming a sealant pattern on any one of first and second substrates to form an injection inlet, bonding the first and second substrates to each other within a vacuum processing chamber, and injecting liquid crystal material through the injection inlet in the other vacuum chamber. The liquid crystal dispensing method, which is disclosed in Japanese Patent Application Nos. 2000-284295 and 2001-005405, includes steps of dispensing liquid crystal on a first substrate, arranging a second substrate on the first substrate, and moving the first and second substrates, thereby bonding the first and second substrates to each other.

Compared to the liquid crystal injection method, the liquid crystal dispensing method is advantageous in that various steps such as, formation of a liquid crystal injection inlet, injection of the liquid crystal, and sealing of the injection inlet are unnecessary since the liquid crystal is previously dispensed on the first substrate, whereby various apparatus for the aforementioned process steps are not required.

Thus, researches and studying are recently made to develop the various apparatus using the liquid crystal dispensing method.

FIG. 1 and FIG. 2 illustrate cross-sectional views of the substrate bonding apparatus to which the liquid crystal dispensing method according to the related art is applied.

In FIG. 1, the substrate bonding apparatus according to the related art includes a frame 10, stages 21 and 22, a sealant dispenser (not shown), a liquid crystal dispensing unit 30, chamber units 31 and 32, a chamber moving system, and a stage moving system.

At this time, the stages include an upper stage 21 and a lower stage 22. The sealant dispenser and the liquid crystal dispensing unit 30 are provided at one side of the frame 10 where a bonding process is carried out. Also, the chamber units 31 and 32 include an upper chamber unit 31 and a lower chamber unit 32.

The chamber moving system includes a driving motor 40 driven to selectively move the lower chamber unit 32 to a location at which the bonding process is carried out, or to a location at which the sealant is dispensed or the liquid crystal is dispensed. The stage moving system includes another driving motor 50 driven to selectively move the upper stage 21 along a vertical direction in perpendicular to the upper and lower stages 21 and 22.

The process of manufacturing the LCD device using the substrate bonding apparatus according to the related art will be described as follows.

First, one substrate (first substrate) 51 is loaded and affixed on the upper stage 21, and the other substrate (second substrate) 52 is loaded and affixed on the lower stage 22.

In this state, the lower chamber unit 32 having the lower stage 22 is moved to a processing location (S1) for the sealant deposition and liquid crystal dispensing by the chamber moving system 40, as shown in FIG. 1.

On completing the sealant deposition and the liquid crystal dispensing, the lower chamber unit 32 is moved to a processing location (S2) for bonding the first and second substrates to each other by the chamber moving system 40, as shown in FIG. 2.

Thereafter, the upper and lower chamber units 31 and 32 are assembled together by the chamber moving system 40 to form a vacuum tight seal, and a pressure in the chamber is reduced by an additional vacuum generating system.

Once a sufficient pressure is attained, the upper stage 21 is moved downwardly by the stage moving system 50 to fasten the second substrate 52 to the first substrate 51, and a continuous pressurization of the chamber completes the manufacture of the LCD device.

[TECHNICAL TASKS TO BE ACHIEVED BY THE INVENTION]

However, the substrate bonding apparatus for manufacturing the LCD device according to the related art has the following disadvantages.

The substrate bonding apparatus for manufacturing the LCD device according to the related art includes the sealant dispenser for the deposition of the sealant, and the liquid crystal dispensing unit for dispensing the liquid crystal on thin film transistor array and color filter substrates as well as a substrate bonding unit, whereby an overall size of the substrate bonding apparatus for manufacturing the LCD device is greatly increased.

Also, a space for bonding the substrates to each other is unnecessarily large, so that it wastes time on making a vacuum state of the space for bonding the substrates.

Finally, the substrate bonding apparatus for manufacturing the LCD device according to the related art has no components for preventing the stage from being bent.

That is, the respective stages may be bent according to the weight in itself and a pressure difference between the interior and the exterior of the substrate bonding apparatus, thereby resulting in a poor bonding state between the first and second substrates.

Accordingly, the present invention is directed to a substrate bonding apparatus for manufacturing an LCD device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a substrate bonding apparatus for manufacturing an LCD device for decreasing the bent intensity in the respective stages.

[PREFERRED EMBODIMENTS OF THE INVENTION]

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, a substrate bonding apparatus for manufacturing an LCD device includes a base frame forming the exterior; upper and lower chamber units mounted on the base frame for being coupled with each other; upper and lower stages in the interior spaces of the respective upper and lower chamber units for affixing one pair of substrates; and a plurality of first elastic members between the chamber unit and the stage.

A substrate bonding apparatus for manufacturing an LCD device according to the present invention will be described with reference to FIG. 3A to FIG. 8.

Referring to FIG. 3A to FIG. 8, the substrate bonding apparatus for manufacturing the LCD device according to the present invention is provided with a

base frame 100, an upper chamber unit 210, a lower chamber unit 220, an upper stage 230, a lower stage 240, a plurality of elastic members, and a sealing means.

Herein, the base frame 100 affixed on the ground forms the exterior of the substrate bonding apparatus, and supports respective components of the substrate bonding apparatus.

Also, the upper and lower chamber units 210 and 220 are respectively mounted on an upper portion and a lower portion of the base frame 100, which are operated for being coupled with each other.

At this time, the upper chamber unit 210 is provided with an upper base 211 exposed to the outside, and a rectangular frame-shaped upper chamber plate 212 affixed to a lower surface of the upper base 211, and having an empty space therein.

Then, the upper stage 230 is affixed to the interior of the upper chamber plate 212.

Also, a first sealing means 213 is provided between the upper base 211 and the upper chamber plate 212 for dividing the interior of the upper chamber plate 212 from the outside.

Next, the lower chamber unit 220 is provided with a lower base 221 affixed to the base frame 100, and a rectangular frame-shaped lower chamber plate 222 having an empty space therein for being moved to all directions on the lower base 221.

At this time, the lower stage 240 is provided in the empty space of the lower chamber plate 222 for being affixed on the lower base 221.

As shown in the substrate bonding apparatus according to the preferred embodiment of the present invention, the lower chamber unit 220 may include a support plate 223 for a stable affixation between the base frame 100 and the lower base 221.

Also, a second sealing means 224 is provided between the lower base 221 and the lower chamber plate 222 to divide a space having the lower stage 240 inside the lower chamber plate 222 from a remaining space.

Furthermore, at least one support unit 225 is provided between the lower base 221 and the lower chamber plate 222, whereby the lower chamber plate 222 is apart from the lower base 221.

At this time, one end of the support unit 225 is affixed to the lower surface of the lower chamber plate 222, and the other end of the support unit 225 is affixed to the lower surface of the lower base 221 for being moved horizontally.

Then, the respective stages 230 and 240 are provided inside the respective chamber units for affixing one pair of substrates. As shown in FIG. 3B, the stages includes adsorbing plates 231 and 241 to which the respective substrates are affixed, and affixing plates 232 and 242 affixed to the respective chamber units 210 and 220.

The respective adsorbing plates 231 and 241 include a plurality of electrostatic chucks for affixing the substrates by an electrostatic force. Preferably, the respective adsorbing plates 231 and 241 include eight electrostatic chucks 231a and 241a.

The respective adsorbing plates 231 and 241 may perform adsorption of the substrate according to a vacuum force, or according to both electrostatic and vacuum forces.

The adsorbing plates 231 and 241 are formed of SUS material or aluminum alloy at a thickness of 40mm or more, thereby preventing the adsorbing plates from being bent.

The elastic members 300 are respectively provided between the chamber units 210 and 220 and the stages 230 and 240 for being pressed to a direction at which the

chamber units 210 and 220 are bent. Thus, even though the chamber units 210 and 220 are bent, it is possible to decrease the bent intensity of the adsorbing plates 231 and 241 of the respective stages 230 and 240.

Especially, it is preferable to affix the elastic members 300 between the adsorbing plates 231 and 241 and the affixing plates 232 and 242. That is, the elastic members 300 are provided to prevent the adsorbing plates 231 and 241 of the respective stages 230 and 240 affixing the substrates 110 and 120 from being bent, so that it is possible to easily bond the substrates 110 and 120 in the bonding process.

As shown in FIG. 4, the respective elastic members 300 are respectively provided between the affixing plates 232 and 242 and the chamber plates 212 and 222 of the chamber units 210 and 220. Optionally, as shown in FIG. 4B, in addition to the plurality of elastic members 300 between the affixing plates 232 and 242 and the respective adsorbing plates 231 and 241, the plurality of elastic members 300 may be additionally provided between the respective affixing plates 232 and 242 and the respective chamber plates 212 and 222 of the chamber units 210 and 220.

The respective elastic members 300 are formed of a press spring, an initially coned disk spring or a plate spring for providing a restoring force to the respective chamber units 210 and 220 when the respective chamber units 210 and 220 are bent. Preferably, the respective elastic members 300 are formed of the initially coned disk springs for providing the restoring force to a wide area as shown in the drawings.

Meanwhile, the respective elastic members 300 have different intensities of the restoring force according to the region where the respective elastic members 300 are positioned, thereby evenly maintaining the respective substrates in the bonding process. That is, the elastic members 300 positioned at the center of the respective stages 230

and 240 have greater intensity in the restoring force as compared to that of the elastic members 300 positioned in the circumference of the respective stages 230 and 240 since the stages 230 and 240 are greatly bent at the center portion according to an external force.

In another aspect, the elastic members 300 may be provided at the center portion of the respective stages 230 and 240, and general blocks may be provided in the circumference of the respective stages 230 and 240.

Preferably, the respective elastic members 300 are provided for being corresponding to the electrostatic chucks 231a and 241a affixed to the adsorbing plates 231 and 241.

The sealing means of a rubber material are formed as O-rings 250 having predetermined heights on the lower chamber plate 222 of the lower chamber unit 220. At this time, the sealing means divides the space inside the respective chamber units 210 and 220 from the exterior of the respective chamber units 210 and 220, whereby the space inside the respective chamber units 210 and 220 is tightly sealed by the sealing means.

As mentioned above, the O-ring 250 has the predetermined height. That is, the O-ring 250 having the predetermined height prevents one pair of substrates 110 and 120 respectively affixed to the stages 230 and 240 from adhering to each other closely. However, the two substrates 110 and 120 are in contact with each other when the O-ring 250 is pressed by the weight of the chamber units.

The process for bonding the substrates with the aforementioned substrate bonding apparatus according to the present invention will be described in detail.

In an initial state of FIG. 3, the first substrate 110, on which a sealant is deposited, is loaded to the interior space between the chamber units 210 and 220 by a loading unit 910 of FIG. 5.

The loaded first substrate 110 is affixed to the upper stage 230 inside the space between the chamber units 210 and 220. After unloading the loading unit 910 to the exterior of the space between the chamber units 210 and 220, the second substrate 120, on which liquid crystal is dispensed, is loaded to the interior space between the chamber units 210 and 220.

Then, the second substrate 120 is affixed to the lower stage 240 inside the space between the chamber units 210 and 220, as shown in FIG. 6.

After completing the load of the first and second substrates 110 and 120, the upper chamber unit 210 moves downwardly by a chamber moving means as shown in FIG. 7A. At this time, the chamber moving means moves the upper chamber unit 210 upwardly and downwardly.

In the drawings, the chamber moving means is provided in the interior of the base frame 100 below the lower chamber unit 220, whereby the chamber moving means moves the upper chamber unit 210 upward and downward according as the chamber moving means is coupled with the upper chamber unit 210.

However, the chamber moving means may be provided in the upper chamber unit 210, whereby the upper chamber unit 210 moves upwardly and downwardly. When moving the upper chamber unit 210 downwardly, the lower surface of the upper chamber unit 210 is in contact with the O-ring 250 on the lower chamber unit 220. Thus, the interior space by the upper chamber unit 210 and the lower chamber unit 220

is sealed tightly. At this time, the first substrate 110 is apart from the second substrate 120 at a predetermined interval.

In the following process, the first and second substrates 110 and 120 are aligned. Then, the aligned first and second substrates 110 and 120 are completely bonded to each other in a vacuum state during the vent process. That is, the space having the first and second substrates 110 and 120, which is the space having the respective stages 230 and 240 inside the chamber units 210 and 220, is maintained in the vacuum state by a vacuum means.

In this case, the center portion of the respective chamber units 210 and 220 is inwardly bent according to the weight of the adsorbing plates 231 and 241 forming the respective stages 230 and 240, and a pressure difference between the vacuum state in the interior space of the chamber units and an atmospheric pressure of the outside. Particularly, the respective affixing plates 232 and 242 of the stages 230 and 240 are increasingly bent, in which the affixing plates 232 and 242 are respectively affixed to the chamber plates 212 and 222 of the chamber units 210 and 220.

However, the elastic members 300 are respectively provided between the affixing plates 232 and 242 and the adsorbing plates 231 and 241 of the stages 230 and 240 to provide the restoring force to the affixing plates 232 and 242 being inwardly bent, so that the respective adsorbing plates 231 and 241 are inwardly bent at a minimum, as shown in FIG. 7B.

Accordingly, the adsorbing plate 231, to which the first substrate 110 is affixed, is maintained in parallel with the adsorbing plate 241 to which the second substrate 120 is affixed, whereby the first substrate 110 is maintained in parallel with the second substrate 120.

That is, even though the center portion of the respective chamber units 210 and 220 is inwardly bent, the adsorbing plates 231 and 241 of the respective stages 230 and 240 are bent at a minimum. On completing the vacuum state in the space having the first and second substrates 110 and 120, the first and second substrates 110 and 120 respectively affixed to the stages 230 and 240 are aligned.

After that, N_2 gas is injected to the interior space of the chamber units 210 and 220 to vent the interior space, as shown in FIG. 8. At this time, the first substrate 110 affixed to the upper stage 230 is separated from the upper stage 230, and bonded to the second substrate 120 by N_2 gas from the upper stage 230.

Subsequently, the first substrate 110 is completely bonded to the second substrate 120 by to the pressure difference according as the vent process is performed. That is, the first and second substrates 110 and 120 are perfectly bonded to each other according to the pressure difference between the atmospheric pressure and the vacuum state of the space having the first and second substrates 110 and 120.

After unloading the first and second substrates 110 and 120 bonded to each other, the process for bonding another pair of substrates to each other is repetitively performed in the substrate bonding apparatus according to the present invention.

[ADVANTAGES OF THE INVENTION]

As mentioned above, the substrate bonding apparatus for manufacturing the LCD device according to the present invention has the following advantages.

The substrate bonding apparatus for manufacturing the LCD device according to the present invention simply performs the process for bonding the substrates without performing the process for dispensing the liquid crystal on the substrate, or depositing

the sealant on the substrate, thereby decreasing the size of the substrate bonding apparatus for manufacturing the LCD device according to the present invention. Thus, it is possible to effectively design a layout, whereby a space for the substrate bonding apparatus according to the present invention decreases.

Also, in the substrate bonding apparatus for manufacturing the LCD device according to the present invention, the space for maintaining the vacuum state is minimized, so that it is possible to minimize the time required for making the vacuum state to bond the substrates to each other. Thus, the time required for manufacturing the LCD device is decreased.

In addition, the plurality of elastic members are provided between the stage and the chamber unit. That is, the adsorbing plates forming the respective stages are bent at a minimum by the plurality of elastic members even though the respective chamber units are inwardly bent according to the weight of the respective stages and the pressure difference between the vacuum state inside the stage and the atmospheric pressure of the outside, whereby the substrates are completely bonded to each other.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.